

# Evaluation of Some Pollution at Manzala Lagoon: Special Reference to Medical Importance of Mollusca in Egypt

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## Abstract

The value of environmental health and the functioning of ecosystems are widely recognized at the Manzala Lagoon for the first time and are becoming more familiar to illuminated public opinions. The freshwater molluscs play significant roles in the public and veterinary health in the Manzala Lagoon region. The abundance of freshwater gastropods species *Biomphalaria alexandrina*, *B. glabrata*, *Bellamya unicolor*, *Viviparous contectus*, *Bulinus (Bulinus) truncatus*, *Lymnaea columella*, *L. (Galba) truncatula*, *Melanooides maculate*, *M. tuberculata*, *Planorbis planorbis*, *Succinea (Amphibina) cleopatra*, *Theodoxus (Neritaea) niloticus* and *T. (N.) anatolicus* was negatively correlated with salinity. These gastropods are of considerable importance because they are hosts for *Cercaria pusilla*, *Fasciola hepatica*, *Schistosoma mansoni* and *Schistosoma haematobium* disease vectors. The latter two can cause Schistosomiasis transmission (Bilharzia). People living along the banks of the drains which are located in southern and western sectors of the Manzala Lagoon are exposed to chemical pollutants. The drains wastewater pollutants affected the human health because they use the drain waters in their life needs.

**Keywords:** Manzala lagoon; Environmental health; Freshwater mollusca

## Introduction

Several factors are considered in affecting the ecology of snails and other intermediate hosts of diseases, hence their focal and seasonal distributions. These include physical factors such as water current, temperature, turbidity, transparency and distribution of suspended solids, chemical factors such as ion concentration and dissolved gases in water as well as biological factors such as availability of food, competition and predator-prey interactions [1,2]. However, the importance of different ecological factors vary significantly from one ecological zone to the other and even from one water body to the other, suggesting local investigations to identify important factors in each zone or water bodies [2-5]. Many studies concerned with the ecology and population dynamics of gastropods which play an important role in transmitting diseases to man and his livestock have been conducted by Abd El-Malek [6]; Dazo et al. [3]; Barbosa and Barbosa [7]; Utzinger et al. [8]; Kloos et al. [9]; Karimi et al. [10]; Cañete et al. [11] Kazibwe et al. [12] and Mostafa [13]. These studies have led to general opinion; that the development of an effective strategy of integrated control requires the study of population dynamics of the intermediate hosts and its relation to environmental factors. Population dynamics of these animals depend on the physical geography of a given region, also land contours, soil composition; hydrography and climate all have effect on snail population dynamics [14].

The main objective of this study is the preparation of a sustainable development plan for the area, and elaboration of methodological procedures for implementation and reliability. One of the specific objectives of the Manzala Lagoon study is to define the environmental state and to identify protection policies, where the freshwater molluscs have been known to play significant roles in the public and veterinary health and thus need to be scientifically exploring more extensively.

Urban and industrial activities would enumerate impacts, sources of pollution, urban solid waste storage, industrial waste and their storage, chemical pollution of water and air, urban sprawl. An adequate reference would be made to relevant Infrastructures of direct and

indirect negative impacts/risks on the environment, mitigation and compensation actions, future consequences.

This study is intended to produce data on the distribution seasonal variations in densities of gastropod molluscs at Manzala Lagoon with emphasis on environmental factors affecting them.

## Materials and Methods

The recent bottom sediments were collected seasonally from seventeen selected stations in the Manzala Lagoon along selected profiles in order to cover his whole area (Figure 1). The sampling was commenced in winter (2010) and continued to summer (2011). The bottom sediments were collected from Manzala Lagoon using a grab sample (Ekman type), which was immersed to depth ranging between 85 centimeters and 160 centimeters. The bottom water temperature was measured by regular mercury thermometer up to 5°C, as well as the heavy metals analyses, the chlorsity and organic matter were determined for bottom sediments in the Manzala Lagoon in different seasons (Tables 1-5).

The collecting of snails was carried out in the selected stations of the Manzala Lagoon. About 100 grams from each sample were dried in an oven at 80-100°C for about 12 hours then soaked for about 24 hours in 10-15% hydrogen peroxide solution. When the chemical reaction was completed, the treated samples were sieved through a 2 mm to 125 mm screen and then dried. The snail species were identified (Plates 1 and 2) and counted (Tables 6-9).

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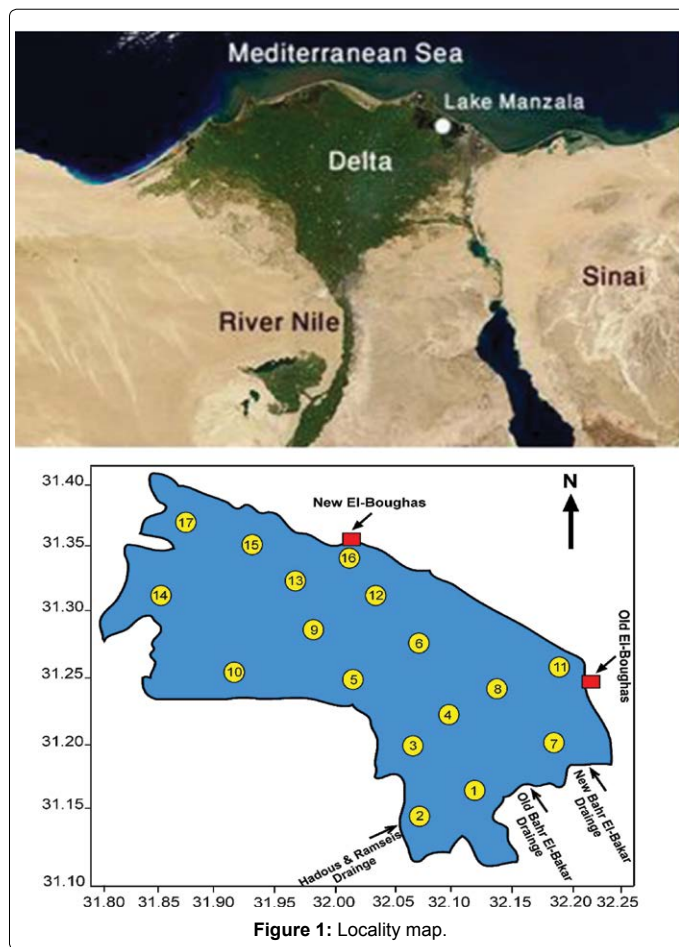


Figure 1: Locality map.

## Sites of Investigation

The collecting of snails was carried out in seventeen sites at Manzala Lagoon (Figure 1). Freshwater mollusca have been known to play significant roles in the public and veterinary health and thus need to be scientifically exploring more extensively [15]. About seven species of freshwater gastropods are reported to act as intermediate hosts for the diagnostic trematode parasites and among Prosobranchs, members of the family Pilidae and Thiaridae were recorded to harbor larval trematodes [16]. Meanwhile, only one genus of saline water was recorded at the area of study (*Cerithium*).

## Manzala lagoon

Manzala lagoon (formerly known as Lake Tanis) is the largest brackish water body (~1071 km<sup>2</sup>) located in the northeastern shoreline of the Nile Delta, and lies between 31° 10" and 31° 40" latitude and 31° 80" and 32° 25" longitude. It is bounded by the Mediterranean Sea to the north, Port Said to the northeast, the Suez Canal to the east, El-Dakahlia Governorate on the southwest, El-Sharkia Governorate on the south, and Damietta on the west (Figure 1). It is a shallow brackish water lagoon, with a depth ranging between 0.7 and 1.5 m [17].

The lagoon has a maximum length of 64.5 km and a maximum width of 49 km. The area of the lagoon has been reduced to 1200 km<sup>2</sup> by 1980 as a result of land reclamation [18]. The original area of Manzala Lagoon was more than 1700 km<sup>2</sup> in 1900 [19].

Manzala Lagoon is connected to the Mediterranean Sea through the outlet of Boughas Al-Gamil (12.5 km west of Port Said) and strait

of Sheikh Ali (25 km northeast of Damietta). It connects with Suez Canal through a small navigation canal known as El-Gaboaty Canal. These openings supply the lagoon with water and fishes. The western and southern shores have many inlets by which great amounts of water drain into the lagoon. The most important drains are Bahr El- Baqar, Hadous, Ramsi, Al-Sirw, Abu-Garida and Faraskur. The lagoon has been missing administrated during the last few decades where it acts as reservoir for wastes fluxing from various directions. Effluents from more than 200 sewage disposal units and about 80 industrial facilities pour into the lagoon [20].

Many drains transport water from the eastern delta to the lagoon, carrying large amounts of particulate matter, nutrients, bacteria, heavy metals, and toxic organics. Methane and hydrogen sulfide bubble up to the surface, releasing greenhouse gases. Therefore, poor water quality of lagoon threatens wildlife, ecosystems, and the health and livelihood of people in the area, while polluting Mediterranean Sea.

## Climate and current regime

The lagoon water attains minimum temperature of 15°C during January-February gradual increase in these values is observed during late winter and spring. They reach the maximum during July-August (Table 1). The maximum values attain 34°C at the beginning of August.

The surface current was measured and listed in Table 1. During winter season a weak current was recorded only in south western part of the lagoon with an average 29 cm /sec. Generally, the maximum velocity of the surface current was recorded in summer season. Rainfall occurs only in winter (November to March), while the summer months are dry. Winds usually blows from north eastern direction in summer.

## Water chloroisty

Chlorosity was measured at each station by arganometric method as recommended in American Public Health Association. The data derived from measurements are listed in Tables 2-5.

During winter season, the chlorosity gradient increases toward the opening of Boughas El- Gameel, and varied from 886.3 mg/l to more than 3000 mg/l at the northern part of the lagoon. During the spring the chlorosity varied from 709 mg/l to 18345 mg/l. During summer season, the chlorosity varied from 15 mg /l to 5034 mg/l. During autumn season the chlorosity of the bottom water ranged from 709 mg/l to 4431 mg/l. It is clear that the maximum value of the water chlorosity was recorded in spring season while the minimum value was recorded in winter season. The obvious increase in the water chlorosity during spring may be due to an increase in temperature and consequently increasing in evaporation. From Tables 2-5 the chlorosity increases toward the inlet of Boughas Al-Gamil at the north portion of the Manzala Lagoon (station 11, 12, 13, 15, 16 and 17).

## Pollution sources

**Agricultural drainage water:** Manzala Lagoon is influenced by fresh water runoff from the land via drains and canals. A total of 3.7 billion cubic meters of water (mostly from agricultural drainage) flow annually into Manzala Lagoon from nine major drains and canals. Bahr El-Bakar Drain has the most polluted drain discharges into Manzala Lagoon. Apart from being the largest consumer of water, agriculture is also a contributor to water pollution. Drainage water seeping from agriculture fields is considered non-point sources of pollution. Moreover, these non-point sources of pollution may also influence the groundwater quality. Major pollutants in agricultural drains are salts; nutrients (phosphorus and nitrogen); pesticide residues (from irrigated

Season Station	Winter		Spring		Summer		Autumn		Annual average	
	Temp. °C	Turbidity NTU	Temp. °C	Turbidity NTU	Temp. °C	Turbidity NTU	Temp. °C	Turbidity NTU	Temp. °C	Turbidity NTU
1	16	59	24	61	32	20	23	29	24	42
2	15	53	24	95	31	80	23	70	23	75
3	19	108	24	93	30	68	24	63	24	83
4	20	32	26	69	33	94	24	48	26	61
5	17	89	-	93	30	32	23	81	23	74
6	-	-	24	94	31	37	25	340	27	157
7	19	89	25	55	32	137	26	69	25	88
8	20	309	26	108	33	26	23	6	25	112
9	15	158	27	59	32	15	25	45	25	69
10	18	45	27	75	31	18	23	57	25	49
11	19	35	23	104	31	29	25	76	24	61
12	20	56	23	79	32	19	24	7	25	40
13	18	72	24	73	32	13	25	18	25	44
14	17	39	24	51	34	9	23	0	24	25
15	15	58	24	65	31	13	23	17	23	38
16	17	47	24	71	32	10	24	8	24	34
17	17	18	24	56	31	8	23	15	24	24
average	18	79	24	77	32	37	24	56	24	63

Table 1: Bottom water temperature (°C) and turbidity (NTU) in the Manzala Lagoon

Parameter Stations	Mn (ug/g)	Iron (mg/g)	Lead (ug/g)	Zinc (ug/g)	Copper (ug/g)	Organic matter (%)	Chloride mg/l
1	280	6.03	27	122	263	0.31	1560
2	335	6.52	16	85	158	0.28	709
3	380	5.66	22	90	206	0.20	957
5	550	6.93	57	96	32	0.30	815
7	200	5.52	14	80	152	0.22	1276
9	225	6.31	68	55	133	0.34	1489
11	230	5.97	9	46	55	0.36	18345
12	310	7.24	10	73	169	0.30	1702
13	260	5.48	4	31	89	0.32	1950
15	230	5.14	5	19	89	0.15	1347
16	245	4.28	4	22	60	0.17	886
17	125	5.28	2	27	76	0.20	922

Table 2: Chemical parameters of bottom sediments in Manzala Lagoon (spring season).

Parameter Stations	Mn (ug/g)	Iron (mg/g)	Lead (ug/g)	Zinc (ug/g)	Copper (ug/g)	Organic matter (%)	Chloride mg/l
1	315	6.66	28	182	387	0.27	1631
2	260	6.28	8	69	166	0.21	425
3	185	5.99	5	92	235	0.25	922
5	475	5.66	26	103	255	0.28	638
7	340	6.72	46	184	430	0.35	15
9	170	5.97	24	39	83	0.15	851
11	275	6.52	4	57	109	0.11	5034
12	365	5.72	16	83	162	0.27	1134
13	236	5.62	8	39	100	0.16	1134
15	115	4.55	1	25	69	0.50	1985
16	120	4.99	12	27	80	0.17	1134
17	185	5.66	39	50	163	0.21	1276

Table 3: Chemical parameters of bottom sediments in Manzala Lagoon (summer season).

Parameter Stations	Mn (ug/g)	Iron (mg/g)	Lead (ug/g)	Zinc (ug/g)	Copper (ug/g)	Organic matter (%)	Chloride mg/l
1	541	7.24	28	134	293	0.33	1773
2	511	6.52	21	41	123	0.30	1595
3	791	5.99	35	77	161	0.26	1418
5	959	6.21	25	92	227	0.30	886
7	349	5.55	17	87	149	0.25	1241
9	511	5.51	18	24	52	0.22	1064
11	301	5.93	16	56	147	0.41	3013
12	467	6.48	7	63	137	0.12	1773
13	620	4.99	22	39	57	0.27	1050
15	296	4.99	17	39	92	0.22	1064
16	324	5.34	18	39	102	0.27	1064
17	205	5.17	7	31	92	0.17	1595

Table 4: Chemical parameters of bottom sediments in Manzala Lagoon (winter season).

Parameter Stations	Mn (ug/g)	Iron (mg/g)	Lead (ug/g)	Zinc (ug/g)	Copper (ug/g)	Organic matter (%)	Chloride mg/l
1	448	5.82	30	137	291	0.23	1595
2	536	6.21	4	106	227	0.16	709
3	685	5.86	19	87	187	0.33	1418
5	946	5.86	21	110	248	0.3	1064
7	367	4.83	4	48	121	0.31	1773
9	554	3.24	7	39	121	0.26	1241
11	398	5.17	12	82	158	0.35	4431
12	166	6.21	13	72	156	0.24	1773
13	367	5.17	9	33	91	0.22	1241
15	230	4.83	4	22	61	0.25	1418
16	224	6.21	4	60	104	0.23	1064
17	189	5.52	7	33	92	0.27	1418

Table 5: Chemical parameters of bottom sediments in Manzala Lagoon (autumn season).

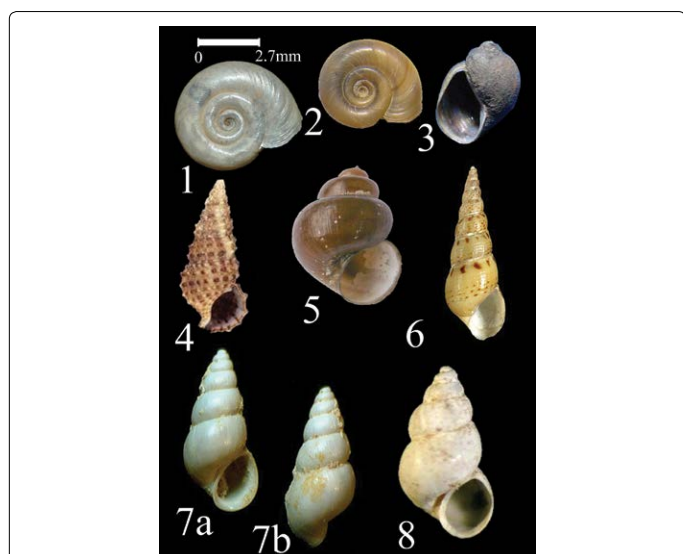


Plate 1: Scale bar for all specimens = 2.7mm. 1) *Biomphalaria alexandrina* (Ehrenberg, 1831). 2) *Biomphalaria glabrata* (Say, 1818). 3) *Bulinus* (*Bulinus*) *truncatus* (Audouin, 1827). 4) *Cerithium scabridum* (Philippi, 1849). 5) *Biomphalaria pfeifferi* (Krauss, 1848). 6) *Viviparus contectus* (Millet, 1813). 7) *Melanooides maculata* Bruguière, 1789. 8) a and b- *Hydrobia* sp. 9) *Hydrobia acuta* (Draparnaud, 1805).

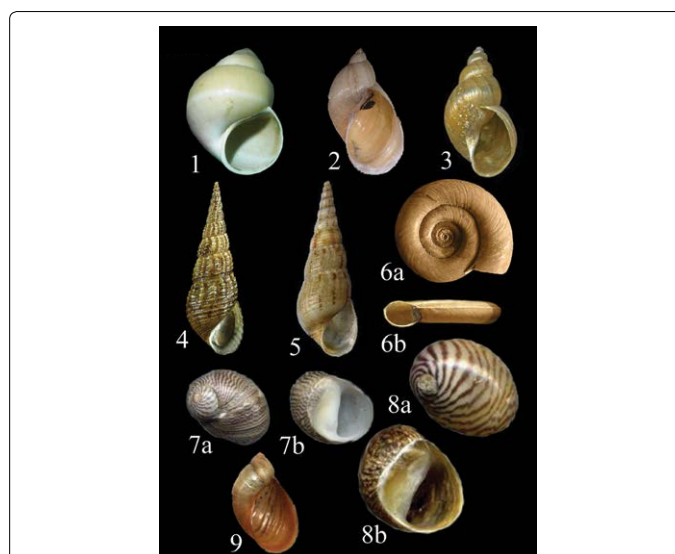


Plate 2: Scale bar for all specimens = 2.7mm. 1) *Bellamya unicolor* (Olivier, 1804). 2) *Lymnaea columella* (Say, 1817). 3) *Lymnaea* (*Galba*) *truncatula* (Müller, 1774). 4.5) *Melanooides tuberculata* (Müller, 1774). 6) a and b - *Planorbis planorbis* (Linnaeus, 1758). 7) a and b - *Theodoxus* (*Neritaea*) *niloticus* (Reeve, 1856). 8) a and b - *Theodoxus* (*Neritaea*) *anatolicus* (Rècluz, 1841). 9) *Succinea* (*Amphibina*) *cleopatra* (Pallary, 1909).

SampleNo.	<i>Bellamyia unicolor</i>	<i>Melanoides tuberculata</i>	<i>Bulinus truncatus</i>	<i>Biomphalaria alexandrina</i>	<i>B. glabrata</i>	<i>B. pfeifferi</i>	<i>Lymnaea columella</i>
1	8	17	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	21	-	-	-	-	-
4	-	21	-	-	-	-	-
5	-	20	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	14	-	-	-	-	-
8	-	12	-	-	-	-	-
9	-	15	30	14	2	1	-
10	-	16	-	-	-	-	-
11	-	23	-	-	-	-	-
12	-	-	-	12	2	1	-
13	-	21	-	-	-	-	-
14	-	22	-	11	1	1	17
15	6	29	-	-	-	-	16
16	4	19	-	14	1	-	22
17	5	17	-	8	-	-	28

Table 6: The total relative densities of snail species act as intermediate hosts of diseases recorded from the studied samples during spring.

Sample No.	<i>Bellamyia unicolor</i>	<i>Melanoides tuberculata</i>	<i>Bulinus truncatus</i>	<i>Biomphalaria alexandrina</i>	<i>B. glabrata</i>	<i>B. pfeifferi</i>	<i>Lymnaea columella</i>
1	10	20	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	22	-	-	-	-	-
4	-	25	-	-	-	-	-
5	-	26	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	24	-	-	-	-	-
8	-	26	-	-	-	-	-
9	-	30	34	18	4	2	-
10	-	30	-	-	-	-	-
11	-	33	-	-	-	-	-
12	-	-	-	12	2	1	-
13	-	34	-	-	-	-	-
14	-	36	-	11	2	1	30
15	8	38	-	-	-	-	32
16	7	33	-	10	1	2	22
17	8	31	-	11	1	-	20

Table 7: The total relative densities of snail species act as intermediate hosts of diseases recorded from the studied samples during summer

fields), pathogens (from domestic wastewater), and toxic organic and inorganic pollutions (from domestic and industrial sources).

More than often, the drains have strong odor due to generation of H<sub>2</sub>S. People living along the banks of the drains are exposed to chemical pollutants [21]. The drains wastewater pollutants affect the human health because they use the drain waters in their life needs. The Bahr El-Bakar drain receives untreated and primary treated wastewater from east Cairo region along its total length of approximately 170 km and discharges into Manzala Lagoon.

### Heavy metals

The studies on heavy metals in rivers, lakes, lagoon, fish and sediments have been a major environmental focus especially in the last decades. Sediments are important sinks for various pollutants like pesticides and heavy metals and also play a significant role in the remobilization of contaminants in aquatic systems under favorable conditions and in interactions between water and sediment [22-25].

**Iron:** The minimum average value of iron was recorded during autumn (5.41 mg/g). It increased gradually during winter (5.83 mg/g) and reached (5.86 mg/g) during spring and summer. Concerning sampled stations, the maximum annual average values of iron were recorded at stations No.1, 2, 5 and 12 being 6.44 mg/g, 6.38 mg/g, 6.17 mg/g and 6.41 mg/g respectively (Tables 2-5).

**Manganese:** The highest average value of manganese was recorded during winter (489.58 µg/g). It decreased gradually during autumn and spring (425.83 µg/g 280.83 µg/g respectively). It reached its lowest average value during summer (253.42 µg/g). Concerning sampled stations, the maximum annual average values of manganese were recorded at stations 2, 3 and 5 being 410.5 µg/g, 510.25 µg/g and 732.5 µg/g respectively (Tables 2-5).

**Lead:** The highest average value of lead was recorded during spring (19.83 µg/g). It decreased gradually during winter and summer (19.25 µg/g, 18.08 µg/g respectively). It reached its lowest average value during autumn (30.33 µg/g). Concerning sampled stations the maximum

Sample No.	<i>Bellamya unicolor</i>	<i>Melanoides tuberculata</i>	<i>Bulinus truncatus</i>	<i>Biomphalaria alexandrina</i>	<i>B. glabrata</i>	<i>B. pfeifferi</i>	<i>Lymnaea columella</i>
1	6	3	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	3	-	-	-	-	-
4	-	4	-	-	-	-	-
5	-	6	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	7	-	-	-	-	-
8	-	9	-	-	-	-	-
9	-	10	19	10	2	1	-
10	-	11	-	-	-	-	-
11	-	13	-	-	-	-	-
12	-	-	-	7	1	-	-
13	-	17	-	-	-	-	-
14	-	20	-	7	-	-	12
15	4	26	-	-	-	-	11
16	2	14	-	3	1	-	13
17	3	12	-	4	-	-	20

Table 8: The total relative densities of snail species act as intermediate hosts of diseases recorded from the studied samples during winter.

Sample No.	<i>Bellamya unicolor</i>	<i>Melanoides tuberculata</i>	<i>Bulinus truncatus</i>	<i>Biomphalaria alexandrina</i>	<i>B. glabrata</i>	<i>B. pfeifferi</i>	<i>Lymnaea columella</i>
1	12	23	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	26	-	-	-	-	-
4	-	28	-	-	-	-	-
5	-	30	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	34	-	-	-	-	-
8	-	32	-	-	-	-	-
9	-	35	39	23	6	4	-
10	-	36	-	-	-	-	-
11	-	33	-	-	-	-	-
12	-	-	-	22	4	2	-
13	-	36	-	-	-	-	-
14	-	40	-	23	4	2	34
15	10	42	-	-	-	-	37
16	9	39	-	20	2	3	32
17	11	37	-	18	2	1	28

Table 9: The total relative densities of snail species act as intermediate hosts of diseases recorded from the studied samples during autumn.

annual average values of lead were recorded at stations 1, 5 and 9 being 28.25 µg/g, 32.25 µg/g and 29.25 µg/g respectively (Tables 2-5).

**Zinc:** The maximum average value of zinc was recorded during summer (79.17 µg/g). It decreased gradually during autumn and spring (69.08 µg/g, 62.17 µg/g respectively). It reached its minimum average value during winter (60.17 µg/g). Concerning sampled stations the maximum annual average values of zinc were recorded at stations 1 and 5 being 143.75 µg/g and 100.25 µg/g respectively (Tables 2-5).

**Copper:** The highest average value of copper was recorded during summer (186.58 µg/g). It decreased gradually during autumn and winter (154.75 µg/g, 136 µg/g respectively). It reached its lowest average value during spring (123.5 µg/g). Concerning sampled stations the maximum annual average values of copper were recorded at stations 1 and 7 being 308.5 µg/g and 213 µg/g respectively (Tables 2-5).

### Organic Matter

From Tables 2-5 it was found that the organic matter content in

the sediments collected in winter season ranges from 0.12% and 0.41% with an average 0.26%, while in spring season it varies from 0.15% and 0.36% with an average 0.25%. During summer season the organic matter content varies from 0.1% to 0.5% with an average 0.23%, while in autumn season it varies from 0.16% to 0.35% with an average 0.27%. The area characterized by low organic matter contents is located at southern part of the lagoon, while the relatively higher organic matter contents were recorded in the east and west of the lagoon.

### Gastropoda study

The gastropods are the largest molluscan group, including marine, freshwater and terrestrial forms, living under different sorts of environmental conditions. The gastropods are divided into three subclasses; one of which the Opisthobranchia is almost exclusively marine, the other two, namely the Prosobranchia and the Pulmonata are well represented in freshwater ecosystem all over Egypt. The two freshwater gastropods subclass can be differentiated from each other by the presence of operculum, sexes are separate, radula has seven teeth

in each transverse row (Prosobranchia), meanwhile the Pulmonata are characterized by the absence of operculum, hermaphrodites, radula with numerous teeth in each row.

**Class:** Gastropoda

**Subclass:** Prosobranchia

**Family:** Neritidae

**Genus:** *Theodoxus*

**Subgenus:** *Neritaea*

*Theodoxus (Neritaea) niloticus* (Reeve, 1856)

Plate 2 (7a) and (7b)

**Distribution:** The subgenus *Neritaea* is restricted to the Lower Nile and reached Africa via Arabia. At least two species occur in the Mediterranean region, along the River Nile and its tributaries from Lake Nasser (Upper Egypt) to Rosetta and Damietta branches (Lower Egypt).

**Size:** The average size is 4.5 mm (H) × 4 mm (W), where (H) and (W) refer to height of spire and width respectively.

**Habitat:** It lives in all types of water and occurs in colonies on and under rocky limestone ledges near the shoreline, associated with many species of aquatic plants. *Theodoxus* needs tidal or wind caused waves to thrive because of its need for high levels of oxygen.

**Remarks:** No species of medical importance.

*Theodoxus (Neritaea) anatolicus* (Récluz, 1841)

Plate 2 (8a) and (8b)

**Distribution:** This species occurs in the Mediterranean region of Syria and Turkey to eastern Greece (The Kos Island, just off the southwest of the Turkish coast). Specimens examined were from Kos Island, Turkey, and Cyprus.

**Size:** The average size is 5.5 mm (H) × 4.5 mm (W).

**Habitat:** Freshwater: springs and seepages, often landlocked, but more commonly found in coastal streams.

**Remarks:** No species of medical importance.

**Family:** Viviparidae

**Genus:** *Bellamya*

*Bellamya unicolor* (Olivier, 1804)

Plate 2 (1)

**Distribution:** The shells are occurring along the River Nile and its main canals and Lake Nasser.

**Size:** The average size is 5.4 mm (H) × 3.5 mm (W).

**Habitat:** Shell is common in all kinds of water bodies, including running, slowly flowing and stagnant water. *Bellamya* occurs in colonies and attached to rubber wheels, plastic packets and rocks.

**Remarks:** It is viviparous and harbours various, larval trematodes of veterinary importance such as *Cercaria pusilla* as well as the rat-lung nematode (*Angiostrongylus cantonensis*).

**Genus:** *Viviparus*

*Viviparus contectus* (Millet, 1813)

Plate 1 (5)

The common name is Lister's River snail. The species is large freshwater snail with an operculum of the family Viviparidae.

**Distribution:** This species is palaeartic in distribution, specifically Europe and western Siberia.

**Size:** The average size is 25 mm (H) × 20 mm (W).

**Habitat:** This large snail lives in slow flowing rivers and canals which are unpolluted, and which have hard water and many water weeds.

**Remarks:** No species of medical importance.

**Family:** Thiaridae (Melaniidae)

**Genus:** *Melanoides*

*Melanoides maculate* Born, 1780

Plate 1 (6)

**Distribution:** The shell is occurring along the River Nile and its tributaries from Upper Egypt to the Rosetta and Damietta Branches. This species is widely distributed across the Indo-west Pacific between the Indo-Malay archipelago and Japan.

**Size:** The average size is 7.3 mm (H) × 2.3 mm (W).

**Habitat:** It lives in stagnant and slowly running water (freshwater) and tolerates high salinity to certain extent.

**Remarks:** The threats to this species are unknown.

*Melanoides tuberculata* (Müller, 1774)

Plate 2 (4) and (5)

**Distribution:** The shell is occurring along the River Nile and its tributaries from Upper Egypt to the Rosetta and the Damietta Branches.

**Size:** The average size is 7.3 mm (H) × 2.3 mm (W).

**Habitat:** It lives in stagnant and slowly running water and tolerates high salinity to certain extent.

**Remarks:** It inhabits several species of Cercariae. It acts as first intermediate host for *Lecithodendrium pyramidum* which has the adult stage in bats.

**Family:** Hydrobiidae

**Genus:** *Hydrobia*

*Hydrobia acuta* (Draparnaud, 1805)

Plate 1 (8)

**Distribution:** This species occurs on the coasts of the Mediterranean Sea and the Black Sea and, as a rare species in Ireland.

**Size:** The species is a very small brackish water snail; with average size is 3.4 mm (H) × 1.6 mm (W).

**Habitat:** This species occurs all the year round crawling in mud. It can occur in great numbers, with individuals at all stages of development, in suitable habitats but seems to prefer more saline places than the other brackish-water Hydrobiidae.

**Remarks:** No species of medical importance.

*Hydrobia* sp.

Plate 1 (7a) and (7b)

**Distribution:** This species occurs on the coasts of the Mediterranean Sea.

**Size:** The species is a very small brackish water snail, with average size is 3.3 mm (H) × 1.5 mm (W).

**Habitat:** This species occurs all the year round crawling in sandy mud. It seems to prefer more saline places than the other brackish-water Hydrobiidae.

**Remarks:** No species of medical importance

**Subclass:** Pulmonata

**Family:** Lymnaea

**Genus:** Lymnaea

*Lymnaea (Pseudosuccinea) columella* (Say, 1817)

Plate 2 (2)

**Distribution:** The shell is occurring in Lower Egypt (the Nile and its main canals) Damietta and Rosetta branches of the Nile especially in El Qaluobyia, El Menoufia and Damietta regions.

**Size:** The average size is 5.4 mm (H) × 3.8 mm (W).

**Habitat:** The species occur in shallow stagnant water, with abundance of lily pads, and on rocky shores which are protected from wave action.

**Remarks:** *Lymanaea (Pseudosuccinea) columella* is an American species introduced into Africa in 1944. It is a possible intermediate host for the trematoda *Fasciola hepatica*.

**Subgenus:** Galba

*Lymnaea (Galba) truncatula* (Müller, 1774)

Plate 2 (3)

**Distribution:** The shell is occurring along the Delta Region, the Bahariya, Dakhla and Kharga oases [26].

**Size:** The average size is 5.5 mm (H) × 3.7 mm (W).

**Habitat:** The species occurs in small streams, pools and temporary waters in cool and humid areas.

**Remarks:** The species is an intermediate host for *Fasciola hepatica*, which is a very common liver fluke in the European ruminants.

**Family:** Succineidae

**Genus:** Succinea

**Subgenus:** Amphibina

*Succinea (Amphibina) cleopatrae* (Pallary, 1909)

Plate 2 (9)

**Distribution:** The shell is occurring along the River Nile and its tributaries from Upper Egypt to Rosetta and Damietta branches (Lower Egypt).

**Size:** The average size is 4.2 mm (H) × 2.7 mm (W).

**Habitat:** The snail living sometimes on reeds in water or on damp ground and climb aquatic plants.

**Remarks:** No species of medical importance.

**Family:** Planorbidae

**Genus:** Planorbis

*Planorbis planorbis* (Linnaeus, 1758)

Plate 2 (6a) and (6b)

**Distribution:** The shell is occurring in Lower Egypt, except El Dakahlyia, so it collected from the Giza and Siwa Oasis (Crawford, 1948).

**Size:** The average size is 2.3 mm (W) × 0.6 mm (H).

**Habitat:** It lives mostly in streams near the water surface on damp floating objects and aquatic vegetation.

**Remarks:** No species of medical importance.

**Genus:** Biomphalaria

*Biomphalaria alexandrina* (Ehrenberg, 1831)

Plate 1 (1)

**Distribution:** The shell is occurring along the River Nile and its main canals and Lake Nasser.

**Size:** The average size is 5.4 mm (W) × 2.2 mm (H).

**Habitat:** Slow flowing or stagnant waters, clear or muddy. It is usually associated with many aquatic plants.

**Remarks:** It acts as an intermediate host of *Schistosoma mansoni* in Egypt. Old publications indicated that this snail was widely distributed in the Nile Delta only, while recent reports show that it has invaded Upper Egypt till Aswan after building High Dam, where it is recorded from Lake Nasser and Abu Simbel.

*Biomphalaria glabrata* (Say, 1818)

Plate 1 (2)

**Distribution:** It has been collected for the first time in Egypt in 1982 and later confirmed during 1995 [27] from irrigation and drainage systems at the Giza, Qalyoubiya and Kafr El Shiekh governorates.

**Size:** The average size is 0.9 mm (H) × 4.4 mm (W).

**Habitat:** The shell lives in slowly-running permanent water bodies. It is highly associated with aquatic plants.

**Remarks:** It is a major intermediate host of *Schistosoma mansoni* in Egypt, USA, Canada and Africa. Recent studies indicate that the density of cercaria liberated from one snail is 4 to 6 times that from *Biomphalaria alexandrina* and hence considered as a new threat for *Schistosomasis* transmission in Egypt [27].

**Genus:** Bulinus

**Subgenus:** Bulinus

*Bulinus (Bulinus) truncatus* (Audouin, 1827)

Plate 1 (3)

**Distribution:** The shell is occurring along the River Nile and its tributaries from Lake Nasser to the Rosetta and the Damietta Branches.

**Size:** The average size is 4.2 mm (H) × 2.1 mm (W).

**Habitat:** Bulinus occurs in all types of waters, clear or muddy waters, including the River Nile, lakes, lagoon, pools and canals.



**Remarks:** *Bulinus (Bulinus) truncatus* is the main intermediate host for *Schistosoma haematobium* in Egypt and other Middle East countries. This snail is also an important transmitter of cattle parasites such as *Schistosoma bovis*.

**Subclass:** Opisthobranchia

**Family:** Cerithiidae

**Genus:** *Cerithium*

*Cerithium scabridum* (Philippi, 1848)

Plate 1 (4)

**Distribution:** This species is distributed in the Red Sea, the Arab Gulf, the Arabian Sea and the Mediterranean Sea.

**Size:** The average size is 6.5 mm (H) × 2.7 mm (W).

**Habitat:** The species lives in intertidal or shallow water zone, on a variety of substrates including sandy mud, rock pools in sheltered places, and lagoons.

**Remarks:** No species of medical importance.

## Results

A total of 11 Genera of gastropod species were recorded in the Manzala Lagoon; belong to 17 species. A separation of freshwater and marine species is clearly evident. The abundance of freshwater gastropods species *Biomphalaria alexandrina*, *B. glabrata*, *Viviparus contectus*, *Bellamya unicolor*, *Bulinus (Bulinus) truncatus*, *Lymnaea (Pseudosuccinea) columella*, *L.(Galba) truncatula*, *Planorbis planorbis*, *Succinea (Amphibina) cleopatra*, *Theodoxus (Neritaea) niloticus* and *T. (N.) anatolicus* was negatively correlated with salinity; while *Cerithium scabridum*, *Melanooides maculate*, *M. tuberculata*, *Hydrobia acuta* and *Hydrobia* sp. show a positive correlation with the same factor (*Melanooides tuberculata* shows tolerate to high salinity). The gastropods *Bulinus (Bulinus) truncatus*, *Bellamya unicolor*, *Biomphalaria alexandrina*, *B. glabrata*, *B. pfeifferi*, *Melanooides tuberculata* and *Lymnaea columella* are of considerable importance because they can act as a host for *Cercaria pusilla*, *Fasciola hepatica*, *Schistosoma mansoni* and *Schistosoma haematobium* disease vectors. The latter two can cause *Schistosomiasis* transmission (Bilharzia). Their distribution is a mostly restricted to the relatively freshwater southern and western sectors of the Manzala Lagoon (Tables 6-9) [28-30].

The total numbers of snail (Figure 2) showed its highest value during autumn (representing 39.60%), followed by summer (25.70%), winter (18.80% (then spring (15.90%), whereas the least numbers were recorded in spring (15.90). The present result agrees with Karimi et al. [10] where they found that late summer and autumn had the optimal temperature required for breeding and reproduction of the collected snails. The April, May and June (the spring months) showed the lowest density of snails in Manzala Lagoon, while the highest density was recorded during January and February (the autumn Months) [31].

The obtained data revealed that the sediments of the western and southern sides (station 1, 2, 3, 4, 5, 7, 10 and 14) of Manzala Lagoon are characterized by very low species diversity indices. This very lowering in species indices can be considered as a response to pollution, and consequently act as a pollution indicator.

The highest average value of heavy metals was recorded during summer, where the maximum annual average values of these metals were recorded at stations 1, 2, 3 and 5.

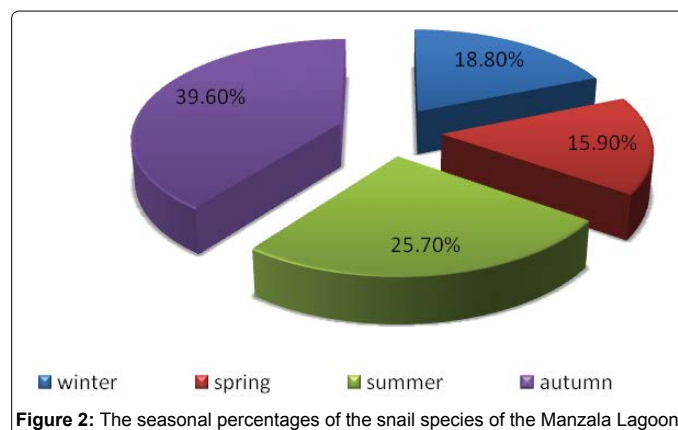


Figure 2: The seasonal percentages of the snail species of the Manzala Lagoon.

## Summary and Conclusions

Coastal area, particularly lagoons have been described in the international literature as typical locations where sediment-associated pollutants can be accumulate due to anthropogenic activities. Biological communities appear to provide a direct means of observing the impact of contaminants.

The present study has been conducted in order to evaluate the degree of pollution and its influence on the mollusca of the Manzala Lagoon, as the gastropods *Bulinus (Bulinus) truncatus*, *Bellamya unicolor*, *Biomphalaria alexandrina*, *B. glabrata*, *Melanooides tuberculata* and *Lymnaea (Pseudosuccinea) columella* are of considerable importance because they acting as a host for *Cercaria pusilla*, *Fasciola hepatica*, *Schistosoma mansoni* and *Schistosoma haematobium* disease vectors. The latter two can cause *Schistosomiasis* transmission (Bilharzia). This work is the first of its kind for the Manzala Lagoon.

The largest consumer of water, agriculture is also a contributor to water pollution. Drainage water seeping from agriculture fields is considered non-point sources of pollution. These non-point sources are, however, collected and concentrated in agricultural drains and become point sources of pollution for the Manzala Lagoon. Major pollutants in agricultural drains are salts; nutrients (phosphorus and nitrogen); pesticide residues (from irrigated fields), pathogens (from domestic wastewater), and toxic organic and inorganic pollutions (from domestic and industrial sources).

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